PLECS

DEMO MODEL

Single-Phase Diode Rectifier with PFC
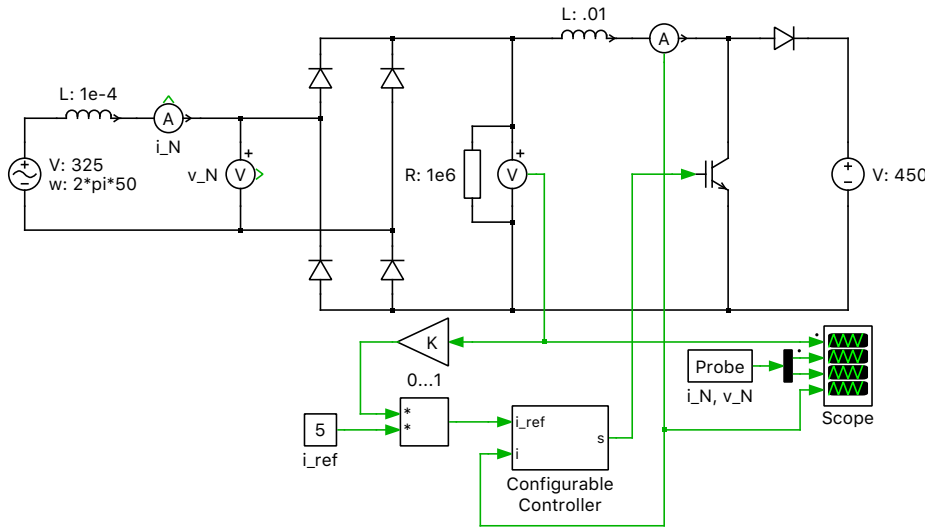
Last updated in PLECS 4.3.1

1 Overview

This example shows a single-phase diode rectifier with power factor correction (PFC). Power factor is a measure of the relative phase difference between the voltage and current signals supplied to a load. It is desired that the phase difference is made as small as possible so that the majority of the power supplied to the load is usable power, also known as real power. PFC circuitry is often incorporated into a design to increase the overall system efficiency and to meet regulatory requirements.

Figure 1: Diode rectifier with PFC

2 Model

2.1 Electrical model

A description of a diode rectifier is given in the demo model "Diode Rectifier" in the PLECS demo models library. The rectifier in this model draws from a $325\,\text{V}$, $60\,\text{Hz}$ AC source and produces an output of $450\,\text{V}$ DC using an ideal voltage source at the load. In order to create a larger voltage at the load than at the input, a boost converter topology is used. The boost inductor with PFC operates the converter in continuous conduction mode (CCM), which effectively reduces the input current harmonics. Buck and buck-boost PFC converters can also be used at the rectifier output depending on the desired application.
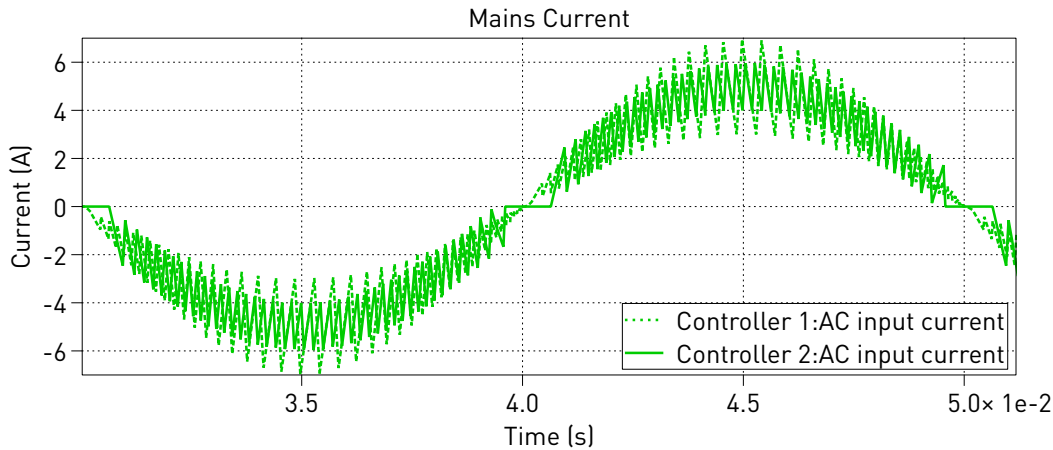
2.2 Control

The PFC control scheme samples the phase of the rectified full-wave voltage via the sense resistor, and shapes the inductor current so it is in phase with the voltage. Since the inductor current is in phase with the rectified AC voltage, the line current drawn by the rectifier is in phase with the mains voltage, and therefore the power factor will be close to unity.

The configurable controller has two implementations that can be toggled and provides a positive half-wave current with a peak reference value of $5\,\text{A}$. There are trade-offs with each control scheme. "Controller 2" uses a relay that distorts the current waveforms as the mains voltage approaches $0\,\text{V}$ twice per cycle, while "Controller 1" is more complex and reduces the distortion at the expense of increased ripple amplitude.

3 Simulation

Run the simulation with the model as provided to view the signals and verify that the DC current is the rectified mains current and has a peak of $5\,\text{A}$, as specified by the reference current set point. Change the Configurable Controller from its default setting of "Controller 1" to "Controller 2" to see the changes in the current waveform as described above. The simulation results are summarized in Fig. 2.

A more advanced switched-mode power supply example that includes an AC input, diode rectifier, boost PFC stage, and non-ideal load is given in the demo model "Boost Converter with PFC and Thermal Model" in the PLECS demo models library.

Figure 2: Results for different controller configurations 1 and 2

Revision History:

PLECS 4.3.1   First release

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